



Solid Oxide Fuel Cells and Defense Applications

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Herbert H. Dobbs, Jr.
Team Leader, Alternative Fuels and Fuel Cells
TACOM National Automotive Center



SOFC's and Defense Applications

Outline



- **Armed Services Interests**
- **Fuel - The sulfur problem**
- **Efficiency - A key logistic issue**
- **PEM versus SOFC**
- **A way forward in ground vehicles**
- **Wrap up**



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Military Fuel Cell Applications



- **Navy**
 - Ship service power
 - Ship Propulsion
- **Air Force**
 - Bare Base - tent city power
 - Flight line generator replacement
- **Army and Marines**
 - Ground vehicle APUs and propulsion
 - Mobile Generators
 - Soldier Power



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Fuel - The sulfur problem

- **Navy**
 - Ship fuel allows up to 10,000 ppm sulfur
 - JP-5 jet fuel allows up to 4,000 ppm
- **Air Force and Ground Forces**
 - JP-8 is the single peacetime and battlefield fuel
 - 3,000 ppm S limit
- **Overseas fuels can have very high sulfur levels**
- **Historically low JP-5/8 sulfur levels are increasing**



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Efficiency and Emissions

- **The U.S. has moved from forward basing to force projection**
- **Logistic support structures must be kept small**
 - Less vulnerable supply systems
 - Faster to deploy
 - Less expensive in peace or war
- **70% of the Army's bulk supply burden is fuel**
- **Emissions are a real military concern**
 - Most military activity is peacetime
 - Military trucks are affected now - ships and aircraft later



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PEM: Advantages and Issues

- **Advantages**
 - PEM fuel cells are available
 - Good efficiency
 - High rate of commercial investment in PEM technology
- **Issues**
 - Difficult cooling in high ambient temperature
 - Noble metal catalysts - cost and scarcity
 - Complex reformer
 - Poor sulfur tolerance
 - Must remove carbon monoxide
 - Penalizes efficiency and power density



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SOFC: Advantages and Issues

- **Advantages**
 - Excellent integration with simplified reformer
 - Potential efficiency of combined cycle
 - Heat rejection is much easier
 - Promotes high power density propulsion systems
 - Long term military vehicle propulsion candidate
- **Issues**
 - Much less mature than PEM
 - Scale up to large vehicle systems
 - Slow startup



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A Way Forward in Ground Vehicles

- **SOFCs offer excellent features for future heavy vehicles, especially military vehicles**
- **Commercial success of SOFCs is the key to broad military adoption**
- **Long haul truck Auxiliary Power Units (APUs) are a major commercial entry point for SOFCs**
 - **Solution to anti-idling restrictions**
 - **Support for separately-powered engine accessories**
- **The APU builds the base for SOFC engines**



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CONTACT



Herbert Dobbs, Jr.

Mailing Address:

U.S. Army TACOM
National Automotive Center
AMSTA-TR-N/272 (Dobbs)
Warren, MI 48397-5000

(810) 574-4228 (voice)

(810) 574-4224 (fax)

dobbsh@tacom.army.mil